AMAZONIANA XIV (1/2): 109 - 120 Kiel, Dezember 1996

Two new and one little-known species of the millipede family Pyrgodesmidae from near Manaus, Central Amazonia, Brazil (Diplopoda: Polydesmida)

by

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(Accepted for publication: July, 1996).

Abstract

Gonographis minuscula n.sp. and *G. duodecimlobata* n.sp. are described, and *Araguayadesmus cochlearius* SCHUBART, 1947, a species hitherto known solely from Pará, is recorded, from material deriving from a nonflooded upland secondary forest (= capoeira) in the vicinity of Manaus. Besides, *Adenomeropus* HOFFMAN, 1966, a monobasic genus from Guyana, is formally synonymized under *Araguayadesmus* SCHUBART, 1947 (syn. n.), and *Adenomeropus fitzgeraldi* HOFFMAN, 1966, is formally reallocated within *Araguayadesmus* (comb. n.).

Resumo

Gonographis minuscula n.sp. e *G. duodecimlobata* n.sp. são descritos e, *Araguadesmus cochlearius* SCHUBART, 1947 - uma espécie conhecida até agora somente do Pará - é registrada, com base em material proveniente de uma floresta secundária, não inundada, de terra firme (= capoeira) nos arredores de Manaus. Também, *Adenomeropus* HOFFMAN, 1966, um gênero monobásico da Guiana, é formalmente sinonimizado sob *Araguadesmus* SCHUBART, 1947, (syn. n.), e *Adenomeropus fitzgeraldi* HOFFMAN, 1966, é formalmente colocado dentro de *Araguadesmus* (comb. n.).

ISSN 0065-6755/1996/109/

Introduction

The Pyrgodesmidae is one of the most usual and diverse millipede families throughout the tropical and, to a lesser extent, subtropical parts of Central (with the Caribbean) and South America, Africa, and Asia together with the Indo-Australian Archipelago. Pyrgodesmids are virtually absent from Australia, New Zealand and extreme south of South America, being only marginal in Morocco and extreme South Africa (but relatively poorly represented also in such a tropical country as Tanzania - HOFFMAN, personal communication), southern Spain, Macaronesia, northern Pakistan, Japan, Florida and Argentina (Map). The only biogeographic pattern which can be made out at the family level is that the taxon is pretty much circumtropical, yet distinctly absent from to poorly represented wherever the Dalodesmidae is strong - Chile, South Africa, Notogaea. Why this is so, is difficult to assess, because both families are neither too similar externally nor, apparently, too closely related phylogenetically.

The taxonomy of this great family has long been acknowledged as being especially badly confused (e.g., HOFFMAN 1980). Most of the about 170 nominal genera (dozens of which are known from the female sex only) currently assigned to Pyrgodesmidae are monobasic, this alone being sufficient as evidence of the poor state of the art. Pyrgodesmids are largely relatively small creatures, usually not exceeding 1 cm in length, this together with the complex gonopod conformation and mostly conspicuously tuberculate, often dirt-coated and/or pilose tergites greatly exacerbating the situation. To improve it, a lot of comparative/revisionary work is thus necessary.

In fact, there are a number of highly promising attempts at putting some order in the presently far too chaotic classification of this family. A careful analysis of useful taxonomic characters in Mesamerican Pyrgodesmidae has confirmed that "the most reliable indicators of relationship in the family are the male gonopods, with pore formulae, tergite ornamentation, and other somatic characters subject to great variation" (SHEAR 1977: 252). Such an approach has already allowed a very considerable reduction in the number of valid genera encountered in Central America, Mexico in particular, to a manageable handful (SHEAR 1973, 1977; HOFFMAN 1976). In addition, several species, sometimes formerly described in various genera and often deriving from vastly disparate regions, have been shown to actually represent but a few widespread, largely parthenogenetic, anthropochores (e.g., HOFFMAN 1993; ENGHOFF 1993).

Regrettably, the recent comparative work of SIMONSEN (1990), devoted to the phylogeny and biogeography of Polydesmida, Pyrgodesmidae included, can hardly be considered exemplary. Based on the structure of only ***two*** pyrgodesmid species, without proper account even of published record, that author provided both a deficient distribution map and a highly inept diagnosis of the family. He simply erred stating that in the Pyrgodesmidae the head is always almost completely covered by the collum (in a number of genera, the head is considerably to almost fully exposed), antennomere 5 longer than antenomere 6 (in fact, these joints are sometimes subequal in length, up to reverse), the paraterga are small (in very many genera, including the ones dealt with here, the paraterga are very prominent), the ozopore formula is normal or ozopores are lacking (there is in reality an unprecedented variety of pore formulas and dispositions in this family), the metaterga are without setae (simple to quite elaborate tergal setae are present in a good number of species), the gonocoxae are enlarged, without cavities (on the contrary, the coxae display a marked trend to growing increasingly incrassate along

with an increasingly well-developed gonocoel, like in some other polydesmidean families), the gonopod telopodites are small, crossing each other (in many species, including some dealt with here, the telopodites are big and held virtually parallel to each other), a solenomerite is present (in fact not always), etc. Beyond any doubt, such a truncated presentation of this and many other polydesmidan families by SIMONSEN (1990) makes virtually all his cladistic analysis spurious and invalid (see also criticism in: GOLOVATCH 1991). The same can generally be said about his zoogeographical exercises, all accomplished within the framework of the so-called "mobilistic biogeography" (see critisism in: ESKOV & GOLOVATCH 1986). To sum up, a much greater amount of evidence is actually necessary to attempt a really comprehensive and thorough analysis of character states, trends and distributions in the Pyrgodesmidae, let alone the latter's internal classification and faunal connections.

The Pyrgodesmidae can be generally defined as a polydesmidean family with the paraterga of varying degree of development, but always directed downward, often lobulated at lateral and/or caudolateral margins, with the dorsum therefore convex, strongly arched, usually with transverse or longitudinal middorsal series of tubercles, those of the median row(s) often hypertrophied and on somite 18 or 19 sometimes coalesced and projecting posteriorly over a small last (19th or 20th) body segment; collum tending to be flabellate, often covering much of the head to entirely concealing it from above, only seldom leaving it almost fully exposed; tergal setation wanting to inconspicuous; ozopores when present at least partly opening on cylindrical porosteles located in front of caudolateral lobule of paraterga, extremely variable in segmental arrangement (from totally missing to present on virtually all somites but collum and telson); antennomere 5 tending to be longer than antennomere 6, only relatively rarely both are subequal in length to reverse; gonopods displaying a marked trend from simple and/or considerably exposed (due to relatively small coxae) toward more or less considerably reduced telopodites for accomodation into an increasingly well-developed and transverse gonocoel (= median cavity developed by hypertrophied gonocoxae), telopodites in situ from subparallel to strongly crossing each other, mostly with 1-2 branches, sometimes with evidence of torsion, largely with a more or less well-developed solenomerite, but without a hairy field/pad at the opening of the seminal groove.

The above diagnosis can be soundly criticised as being obviously too broad and all-embracing, just an opposite to the truncated presentation by SIMONSEN (1990). Still nothing better than a few trends observed in this family can be proposed as defining it as a whole at the presently far too chaotic stage of classification of the entire suborder Polydesmidea the Pyrgodesmidae belongs to. Like in most other polydesmideans, each character/trend taken separately would certainly be insufficient for a proper family allocation, so only in combination they may serve as guidelines.

In terms of biodiversity, the New World pyrgodesmid fauna has long been acknowledged as being particularly rich. Even considering all established and even some possible synonyms, South America south of Panama alone currently supports over 40 genera and almost 60 species of Pyrgodesmidae, over a half of which occur in Brazil. Despite the fact that some more synonyms are very likely to be actually involved, the real numbers of Neotropical pyrgodesmid species and, to a lesser extent, genera are surely highly impressive and may very well prove to be several times as many as known to date. At least such is the impression derived from already available materials concerning the Manaus faunule, which alone harbours dozens of pyrgodesmid species,

many of these very difficult to place in a genus and still warranting a description as new to science (see review in: GOLOVATCH et al. 1995).

The present paper puts on record two new and one little-known pyrgodesmid species from Central Amazonia of Brazil, being another contribution to the assessment of a yet poorly known diplopod faunule of the Manaus region as revealed in the course of long-term and on-going research on the arthropod fauna and ecology of tropical inundation and upland forests by ADIS (1992a, b) and collaborators. Although this is but a minor fraction of what still remains to be described from near Manaus, one cannot avoid a careful, step-by-step treatment of J. ADIS' extremely interesting millipede collections, especially concerning such a difficult and taxonomically confused family as Pyrgodesmidae.

Because of their much more evident affinities/identities compared to most of the remaining pyrgodesmids from the great ADIS Collection, only three species are dealt with here. Two of these are new and represent *Gonographis*, and the third is a lille-known *Araguayadesmus*.

Material

All material treated here has been taken by means of soil extraction in a secondary tropical upland forest at Rio Tarumã Mirím (for more information, see ADIS 1992b). Both holotypes and the bulk of paratypes and non-types have been deposited in the Instituto Nacional de Pesquisas da Amazônia (INPA), Manaus, Brazil, while a few paratypes and non-types have been retained for or shared with the collections of the Zoological Museum of the State University of Moscow (ZMUM), Senckenberg Museum, Frankfurt a. M. (SMF), Zoologisk Museum, University of Copenhagen (ZMUC), Muséum d'Histoire naturelle, Geneva (MHNG), and J. ADIS (CA).

Historical

Only two pyrgodesmids have hitherto been recorded in the environs of Manaus, namely *Gonographis adisi* HOFFMAN, 1985, and *Muyudesmus obliteratus* KRAUS, 1960 (cf. HOFFMAN 1985; ADIS 1986; MESSNER & ADIS 1988). The former species is unique in being "aquatic", perhaps the only millipede capable to survive submersion up to 11 months due to the conspicuous structure of its plastron. The latter species is likely to be only a bisexual form of the ubiquitous? parthenogenetic *Poratia digitata* (PORAT, 1889), which was described originally from a Swedish hothouse. Near Manaus, *G. adisi* seems to be restricted to blackwater inundation forests and, since the areas taken up by such woodlands in Amazonia are huge, one might suggest a fairly wide distribution of that terricolous but trunk-crawling millipede. *M. obliteratus* is likewise sylvicolous, most probably Neotropical in origin, being definitely quite common and widespread in South and Central America (reported from various parts of Peru, Brazil, Paraguay, Argentina, Costa Rica, etc., mostly sub *P. digitata* - cf. SCHUBART 1947b; KRAUS 1960). In the environs of Manaus alone, it inhabits various types of inundation (whitewater = várzea, blackwater = igapó, and mixedwater) and nonflooded upland forests (Terra firme), among the latter especially in disturbed and secondary (= capoeira) ones. It occurs on the soil, in forest litter and even on epiphytes in tree crowns. Due to its deficient plastron, this forest dweller cannot tolerate submersion and escapes inundations through migration to the non-inundated tree trunks and canopy areas (ADIS 1986; MESSNER & ADIS 1988).

Taxonomic part

Gonographis minuscula n.sp. (Figs. 1-5)

Holotype: ♂ (INPA), Brazil, Edo. Amazônas, environs of Manaus, Terra firme (= nonflooded upland forest), Rio Tarumã Mirím, 3°2'S, 60°17'W, secondary tropical forest (= capoeira), soil extraction, 28.III.1983; leg. J.M. RODRIGUES, J. ADIS et al.

Name: Emphasizes the creature's particularly small size.

Diagnosis: Differs from congeners by only 19, not 20, body segments (♂), particularly small body size coupled with certain details of gonopod structure.

Description: Length ca. 2.7 mm, width 0.55 mm. Colour in alcohol entirely pallid, metaterga whitish (currently at places a little coated with Indian ink for a more clear display of tergal sculpture).

Body with 19 segments (♂). Head distinctly flattened, vertigial part elevated and coarsely shagreened/microtuberculate, with 2+2 indistinct ridges converging toward antennal sockets. Antennae quite strongly clavate, rather short, in situ almost reaching the end of body segment 2 (Fig. 1), geniculate between joints 3 and 4; joint 5 evidently longer and bigger than 6th, like in *G. adisi* (topotypes revised).

Collum (Fig. 1) as usual in the family and genus, flabellate, with ten lobes at an elevated fore margin, with 3+3 and 2+2 tubercles in middle and rear rows, respectively. Surface irregularly microgranulate to microreticulate, dull.

Surface of prozona and ventral parts of metazona rather delicately shagreened. Like collum, subsequent metaterga densely microgranulate to microreticulate and more or less strongly tuberculate, with usual three transverse rows of 2+2 bigger, coniform, blunt, subequal, paramedian tubercles (**PM** and **DL** in the sense of HOFFMAN 1976) and a number of vague but traceable knobs somewhat laterad; series **md** and **int** sensu HOFFMAN (1976) indistinct (Figs. 1-3). Paraterga sloping down ventrad, very prominent, with three distinct lobes laterally, with another three (more deeply incised) lobes distocaudally (Figs. 1-3). Porosteles small but evident, placed on still traceable **LP 3** on body segments 5, 7, 9, 10, 12, 13, 15-16; onward inconspicuous ozopores opening directly on dorsal paranotal surface on body segments 17-18.

Epiproct (Fig. 3) very short, truncated, fully exposed in dorsal view, directed ventrocaudally, surmounted with a bundle of setae, with a little but distinct lobule on either side and a few granulations dorsally, all obviously belonging to last segment.

Legs invisible from above, unmodified, tarsi more slender than preceding podomeres. Sterna very narrow.

Gonopods (Figs. 4, 5) in situ barely crossing each other near tip. Coxite relatively small, non-globose, finely granulate and microsetose, only anteromedially with 2+2 particularly strong macrochaetae. Telopodite with a transverse and more strongly setose prefemur. Acropodite rather slender, gradually attenuating toward tip, with a relatively little, simple, posteromedian, solenomerite branch at about midlength opposed by a conspicuous row of shorter setae; a rudimentary, simple, spiniform, anteromedian, parabasal "graphium" (cp. SCHUBART 1945; HOFFMAN 1985 for other congeners); and a peculiar, slightly curved, apical process.

Gonographis duodecimlobata n.sp. (Figs. 6-10)

Holotype: ♂ (INPA), Brazil, Edo. Amazônas, environs of Manaus, Terra firme (=nonflooded upland forest), Rio Tarumã Mirím, 3°2'S, 60°17'W, secondary tropical forest (= capoeira), soil extraction, 25.IV.1983; leg. J.M. RODRIGUES, J. ADIS et al. - Paratypes 1 ♂, 1 ♀, 1 juv. (19 segm.) (CA), 1 ♂ (INPA), 1 ♀, 1 juv. (19 segm.) (ZMUM), same data, together with holotype. - 1 ♀ (INPA), same data, 29.IX.1982. - 1 ♀ (INPA), same data, 29.XII.1982; all leg. J.M. RODRIGUES, J. ADIS et al. - Non-type: 1 juv. (17 segm.) (INPA), same data, together with holotype of *G. minuscula*.

Name: Emphasizes the presence of 12 lobes at the fore margin of the collum.

Diagnosis: Differs from congeners by the 12-lobed front margin of the collum and certain details of gonopod structure, in particular the complete absence of a "graphium".

Description: Length ca. 6.7-9 (♂) to 10 mm (♀), width 1.3-1.45 (♂) to 1.55 mm (♀). Holotype ca. 9 mm long and 1.5 mm wide. Colour in alcohol entirely pallid, metaterga whitish.

Body with 20 segments (♂, ♀). Head distinctly flattened, vertigial part elevated, granulorugose, with 2+2 rather distinct ridges converging toward antennal sockets. Antennae quite strongly clavate, rather short, in situ almost reaching the end of body segment 2, geniculate between joints 3 and 4; joint 5 evidently longer than 6th.

Collum (Fig. 6) as usual in the family and genus, flabellate, with 12 lobes at an elevated fore margin, with 2+2 and 3+3 tubercles in middle and rear rows, respectively. Surface irregularly microgranulate to microtuberculate, dull.

Surface of prozona and ventral parts of metazona microporose, shagreened. Like collum, subsequent metaterga basically extremely delicately and densely microgranulate to microtuberculate and more or less strongly tuberculate, with usual three transverse rows of 2+2 bigger, high, coniform, blunt, paramedian tubercles and a number of grains/microtubercles both in between and laterally; dorsal tuberculation pattern typical: 1+1 **md**, 1+1 **PM**, 2+2 **int**, 1+1 **DL** sensu HOFFMAN (1976) (Figs. 6-8). Suture between pro- and metazona microreticulate. Paraterga sloping down almost to level of ventrum, very prominent, with three (until body segment 4) or four (from body segment 5 onward) distinct marginal lobes laterally (**LP**, lobulation traceable ventrally as well), another three (more deeply incised) lobes distocaudally, one lobe distofrontally and 3-4 rows of more or less scaly knobs dorsally. Porosteles small but evident, placed on still traceable **LP 3** on body segments 5, 7, 9, 10, 12, 13, 15-16 only.

Epiproct (Fig. 8) rather short, truncated, fully exposed in dorsal view, directed ventrocaudally, surmounted with a bundle of setae, with two rows a little but distinct and oblong tubercles dorsally.

Legs invisible from above, unmodified, tarsi more slender than preceding podomeres. Sterna very narrow, each rear one with a paramedian pair of minute knobs caudally. Epigynal ridge behind ♀ legpair 2 like an extremely low, roundly trapeziform, thin blade.

Gonopods (Figs. 9-10) in situ not crossing each other. Coxite relatively small, non-globose, finely granulate and microsetose, only anteromedially with 2+2 particularly strong macrochaetae. Telopodite with a transverse and more strongly setose prefemur. Acropodite rather slender, gradually attenuating toward an acuminate tip, with a relatively little, simple, posteromedian, midway, acuminate solenomerite branch almost reaching the tip of main telopodite and opposed by a conspicuous row of setae; no rudiment of a "graphium", instead an anterobasal sacciform protuberance.

Remarks: The genus *Gonographis* SCHUBART, 1945, has hitherto been known to comprise only two species: *G. hastata* SCHUBART, 1945 (the type-species), and the abovementioned *G. adisi*. Both forms are rather small, only 5-8 mm in length, in peripheral as well as in gonopodal traits they are unquestionably very closely related, especially so due to the presence of a "graphium" on the gonopod telopodite and a separate solenomerite branch. However, their ecologies seem to be widely disparate. Whereas *G. adisi* appears "aquatic" (see above), *G. hastata* seems to be a largely synanthropic element quite common and widespread in Brazil (Pará, Bahia, Rio de Janeiro, Distrito Federal) and Argentina (Tucuman), often associated not only with human settlements, but also with ant nests or termitaria (cf. SCHUBART 1944, 1945, 1947a, b, 1952, 1954). On the other hand, both *G. minuscula* and *G. duodecimlobata* seem to be restricted to upland woods, with preference neither to inundation forests nor to ant/termite nests, most probably not even to human settlements. In other words, displaying evidently similar and more "usual" ecologies (both species occur syntopically and have been even taken together), both new forms considerably broaden the range of ecological performances of *Gonographis*.

The same concerns the taxonomic concept of *Gonographis* as well. Both new species appear relatively disjunct. In paticular, *G. minuscula* deviates in the number of body segments (19) and a vestigial "graphium" on the gonopods, while *G. duodecimlobata* in the number of lobes (12) at the fore margin of the collum and a completely reduced "graphium". Very close relationships between these two new species are revealed first of all in the general configuration of the gonopods and, especially, the conspicuous row of setae on the caudal surface level to the solenomerite. In other words, inclusion of *G. minuscula* into

Gonographis as defined by both SCHUBART (1945) and HOFFMAN (1985) is warranted because of the same peripheral and gonopod conformation coupled with the presence of a rudimentary graphium, whereas the attribution of *G. duodecimlobata* to *Gonographis* is less straightforward, being based only on certain striking similarities in gonopod structure shared by both new species concerned.

To sum up, there seems to be no doubt that at least at the present state of our knowledge of the Neotropical Pyrgodesmidae, both new species are much more closely related to *G. hastata* and *G. adisi*, as well as to each other, than to any other taxon described to date. Hence all these four species appear to belong in a single, apparently rather polymorphous genus. Moreover, discovery of its further new members is very easy to predict.

Araguayadesmus cochlearius SCHUBART, 1947 (Figs. 11-15)

Material: numerous ♂♂, ♀♀ (INPA), 3 ♂♂, 4 ♀♀ (ZMUM), 1 ♂, 2 ♀♀ (ZMUC), 1 ♂ (SMF), 1 ♂ (MHNG), 2 ♂♂ (CA), Brazil, Edo. Amazônas, environs of Manaus, Terra firme (= nonflooded upland forest), Rio Tarumã Mirím, 3°2'S, 60°17'W, secondary tropical forest (= capoeira), soil extraction, 22.XII.1976 & 2.II.1977; - 1 ♂ (INPA), same data, 10.III.1977; all leg. J.M. RODRIGUES, J. ADIS et al. - 3 ♂♂, 2 ♀♀ (INPA), same locality, on epiphytes, 29.-31.X.1980; leg. J. ADIS et al.

Remarks: Like *Gonographis*, the genus *Araguayadesmus* SCHUBART, 1947, has heretofore been known to comprise only two constituent species, namely *A. ligulifer* SCHUBART, 1947a (the type-species), and *A. cochlearius* SCHUBART, 1947a, both from Pará, Brazil, neither having been rediscovered since the original description (SCHUBART 1947a). All the more important and interesting seems the above, second record of *A. cochlearius*, this time from as far away from the terra typica as the vicinity of Manaus.

In addition, *Araguayadesmus* appears the same as *Adenomeropus* HOFFMAN, 1966, monobasic, with the type-species *A. fitzgeraldi* HOFFMAN, 1966, known only from Pacaraima Mts., Guyana (cf. HOFFMAN 1966). Indeed, the main differences between both lie in the crossing vs. non-crossing gonopods as well as in the relatively strongly tuberculate vs. almost bare metaterga, respectively. All other traits are virtually identical, especially the modified ♂ prefemur 3 and the gonopod conformation. Discovery of intermediates is likely in the future, but even without this, there seems every reason to formally synonymize *Adenomeropus* under *Araguayadesmus* (syn. n.!), and to reallocate *Adenomeropus fitzgeraldi* within *Araguayadesmus* (comb. n).

A. cochlearius has hitherto remained known only from a single male holotype taken from a vegetable garden at Aurá, Rio Araguaia, Pará (cr. SCHUBART 1947a). The new samples at hand contain numerous males and females, all in full agreement with the original description. This extends very considerably the established range of that little-known species to Amazônas and sheds additional light on its ecology. Thus, *A. cochlearius* seems quite common at least in an upland secondary forest (= capoeira) near Manaus and probably represents another sylvicole obviously displaying certain inclinations to synanthropization. The discovery of this species on epiphytes in tree crowns shows that we obviously face another forest floor-dweller capable of climbing the trees and colonizing even certain synanthropic habitats.

The new illustrations (Figs. 11-15) are presented to confirm the identity. They also reveal the pattern of tergal ornamentation which only very slightly differs from that depicted by SCHUBART (1947a) for *A. ligulifer*. In particular, marginal lobulation of the paraterga seems somewhat less strongly incised in *A. cochlearius* as compared to *A. ligulifer*. Besides, the size of Manaus specimens of *A. cochlearius* ranges from 8-11 mm in length and 1.4-1.65 mm in width, as opposed to 8.5-9 mm in length and 1.5-1.6 mm in width in *A. ligulifer*. Generally, ♂♂ are a little smaller than ♀♀. Coloration is mostly uniform pallid, often somewhat yellowish. The epiproct is very broadly truncate, flanked by two lobuliform, quite prominent tubercles on each side. Sternal cones are small but evident, median plate between the ♂ coxae 4 is roundly triangular in shape, quite prominent, directed ventrocaudally. The ♂ prefemur 3 is supplied with a prominent, digitiform, frontomesal process distally. The epigynal ridge behind the ♀ coxae 2 looks like a regularly rounded blade, directed ventrally, rather high, medially almost as high as the coxa proper,

the latter is with an inner cone.

All above somewhat broadens our knowledge concerning both ecological and structural variation in *Gonographis, Araguayadesmus*, and *A. cochlearius*.

Acknowledgments

I am greatly obliged to both PD Dr. W.J. Junk and PD Dr. J. Adis who helped me obtain a grant from the Max-Planck-Society to work at the MPI for several weeks in March-April 1994 and October-November 1995 in close collaboration with Dr. Adis. I wish to acknowledge the support rendered to me by the Max-Planck-Society as well as the great help and hospitality of my colleague and friend Dr. Joachim Adis whose enthusiastic research in the Amazon region of Brazil has yielded very important materials. Also, I am very grateful to Mrs. Irmgard Adis, Miss Bethania Adis, and Miss Susanne Hamann for their technical assistance. Besides, Dr. Richard L. Hoffman (Martinsville, Virginia, U.S.A.), Dr. Jean-Paul Mauriès (Paris, France) and Dr. Henrik Enghoff (Copenhagen, Denmark) have been kind enough to share their opinions, revised the final draft and suggested several improvements.

References

ADIS, J. (1986): An "aquatic" milliped from a Central Amazonian inundation forest. - Oecologia, Berl. **68**: 347-349.

ADIS, J. (1992a): How to survive six months in a flooded soil: Strategies in Chilopoda and Symphyla from Central Amazonian floodplains. - Stud. Neotrop. Fauna Environment **27**(2-3): 117-129.

ADIS, J. (1992b): Überlebensstrategien terrestrischer Invertebraten in Überschwemmungswäldern Zentralamazoniens. - Verh. naturwiss. Ver. Hamburg **33**(N.F.): 21-114.

ENGHOFF, H. (1993): Cape Verdean millipedes (Diplopoda). - Trop. Zool. **6**: 207-216.

ESKOV, K.Y. & S.I. GOLOVATCH (1986): On the origin of trans-Pacific disjunctions. - Zool. Jb. Syst. **113**: 265-285.

GOLOVATCH, S.I. (1991): The millipede family Polydesmidae in Southeast Asia, with notes on phylogeny (Diplopoda, Polydesmida). - Steenstrupia **17**(4): 141-159.

GOLOVATCH, S.I., HOFFMAN, R.L., ADIS, J. & J.W. DE MORAIS (1995): Identification plate for the millipede orders populating the Neotropical Region south of central Mexico. - Stud. Neotrop. Fauna Environment **30**(3): 159-164.

HOFFMAN, R.L. (1966): Polydesmoid Diplopoda from the Pacaraima Mountains. - J. Zool. **148**: 540-553.

HOFFMAN, R.L. (1976): A new lophodesmid milliped from a Guatemalan cave, with notes on related forms. - Rev. suisse Zool. **83**(2): 307-316.

HOFFMAN, R.L. (1980): Classification of the Diplopoda. - Mus. Hist. nat. Genève, 237 pp.

HOFFMAN, R.L. (1985): A new millipede of the genus *Gonographis* from an inundation forest near Manaus, Brazil (Pyrgodesmidae). - Amazoniana **9**(2): 243-346.

HOFFMAN, R.L. (1993): Status of *Calyptodesmus schubarti* CAUSEY, 1960, a myrmecophilous milliped (Polydesmida: Pyrgodesmidae). - Insecta Mundi **7**(3): 191-192.

KRAUS, O. (1960): Myriapoden aus Peru, IX. - Senckenbergiana biol. **41**(3/4): 241-264.

MESSNER, B. & J. ADIS (1988): Die Plastronstrukturen der bisher einzigen submers lebenden Diplopodenart *Gonographis adisi* HOFFMAN, 1985 (Pyrgodesmidae, Diplopoda). - Zool. Jb. Anat. **117**: 277-290.

SCHUBART, O. (1944): Os Diplópodos de Pirassununga. - Acta Zool. Lilloana **2**: 321-440.

SCHUBART, O. (1945): Os Proterospermophora do Distrito Federal (Myriapoda, Diplopoda). - Arq. Mus. Nac. **38**: 1-156.

SCHUBART, O. (1947a): Os Diplopoda da viagem do naturalista Antenor Leitão de Carvalho aos rios Araguaia e Amazonas em 1939 e 1940. - Bol. Mus. Nac., N.S., Zool. **82**: 1-74.

SCHUBART, O. (1947b): O elemento "synanthropo" e estrangeiro entre os Diplopoda do Brasil. - Arthropoda **1**(1): 23-40.

SCHUBART, O. (1952): Diplopoda de Pirassununga IV. Adenda a fauna regional. - Dusenia **3**(6): 403-420.

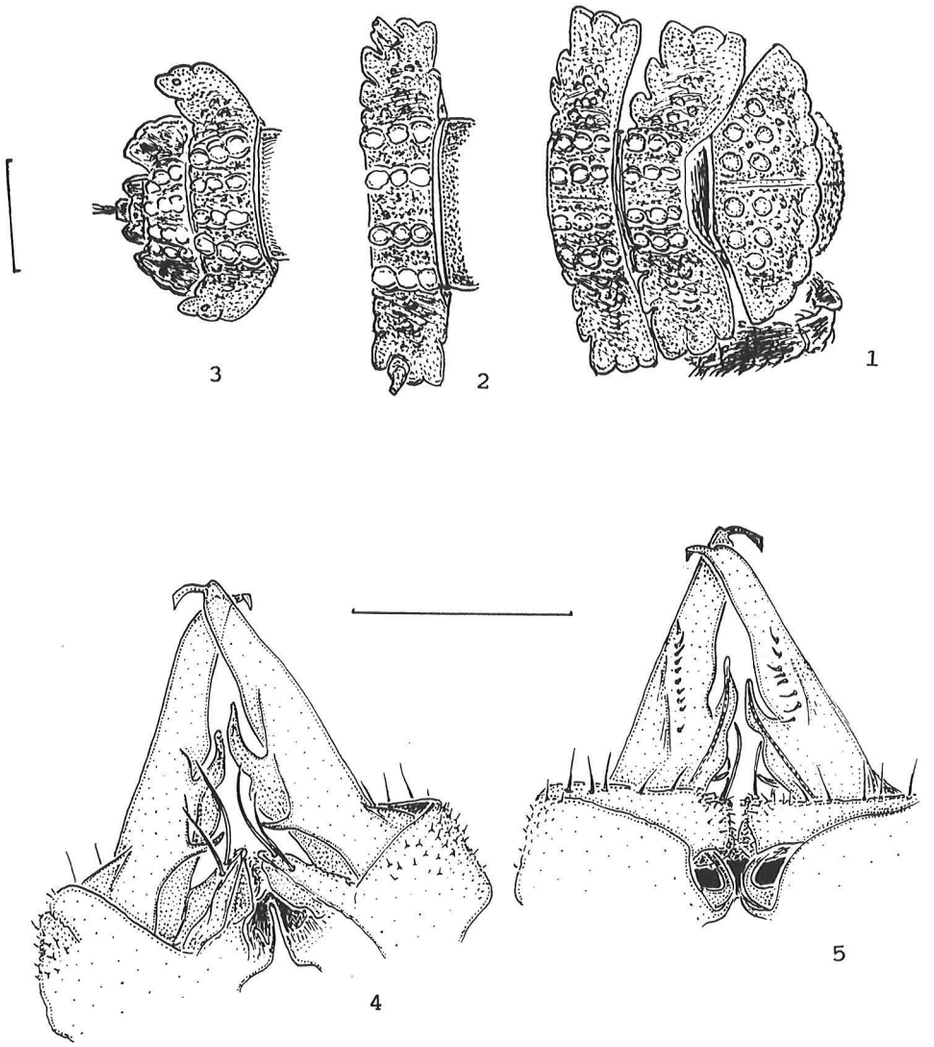
SCHUBART, O. (1954): Diplópodos argentinos del Museo de la Ciudad Eva Peron. - Notas del Museo, Fac. Cienc. nat. y Mus., Univ. Nac. Eva Peron **17** (Zool. 150, 154, 155): 309-358.

SHEAR, W.A. (1973): Millipeds (Diplopoda) from Mexican and Guatemalan caves. - Subterranean fauna of Mexico, 2. Problemi Attuali di Scienza e di Cultura, Quaderno Accad. Naz. Lincei **171**: 239-305.

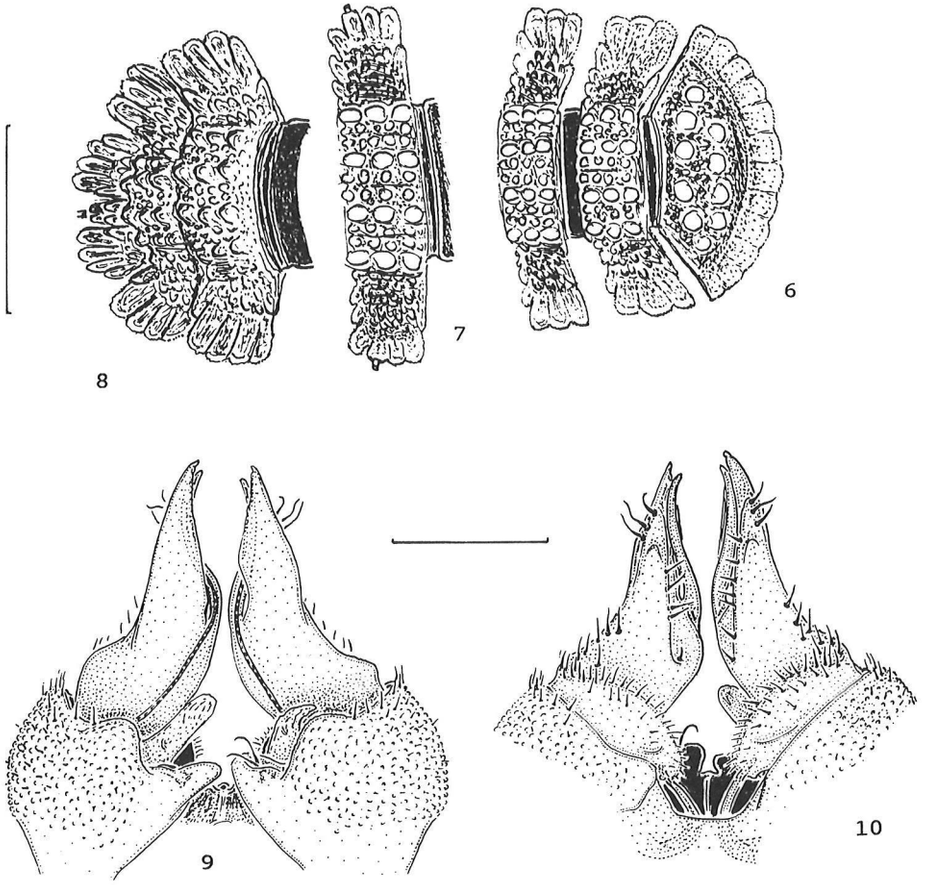
SHEAR, W.A. (1977): Millipeds (Diplopoda) from caves in Mexico, Belize and Guatemala. III. - Subterranean fauna of Mexico, 3. Problemi Attuali di Scienza e di Cultura, Quaderno Accad. Naz. Lincei **171**: 235-265.

SIMONSEN, A. (1990): Phylogeny and biogeography of the milliped order Polydesmida, with special emphasis on the suborder Polydesmidea. - Mus. Zool. Univ. Bergen, 114 pp.

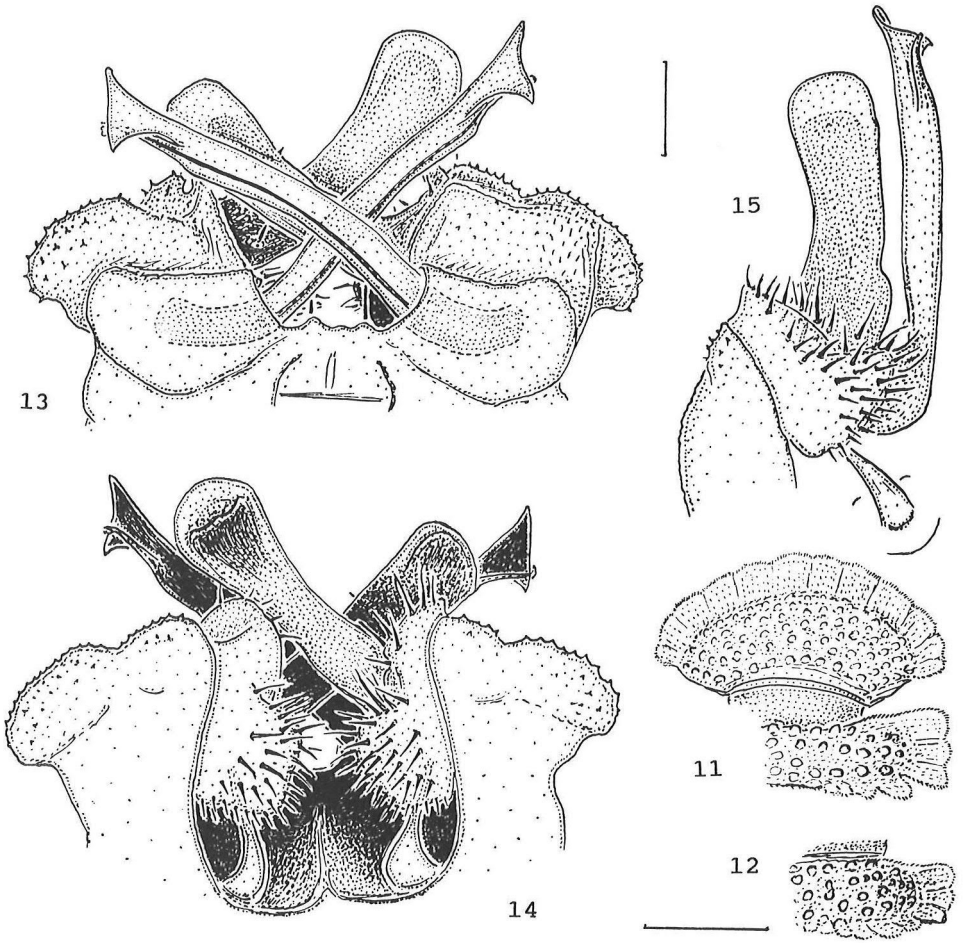
Map:
Distribution of Pyrgodesmidae; occurrence in the Cape Verde Islands not shown (modified after SIMONSEN 1990).



Figs. 1-5:
Gonographis minuscula n.sp., ♂ holotype.
1: anterior body end, dorsal; **2**: body segment 10, dorsal; **3**: caudal body end, dosal; **4-5**: gonopods, frontal and caudal, resp. Scales 0.2 (1-3) and 0.1 mm (4-5).



Figs. 6-10:
Gonographis duodecimlobata n.sp., ♂ paratype.
6: anterior body end, dorsal; **7**: body segment 10, dorsal; **8**: caudal body end, dorsal; **9-10**: gonopods, frontal and caudal, resp. Scales 0.2 (1-3) and 0.1 mm (4-5).



Figs. 11-15:
Araguayadesmus cochlearius SCHUBART, 1947 (♂).
11: anterior body end, dorsal; **12**: body segment 10, dorsal; **13-15**: gonopods, frontal, caudal, and lateral, resp. Scales 0.5 (11-12) and 0.1 mm (13-15).